Structural and biochemical analysis of extracellular matrix formed by jaw periosteal cells

Prof Dr Dorothea Alexander-Friedrich, University Hospital Tübingen, Dept. of Oral and Maxillofacial Surgery, Germany

MSc Marina Danalache, University Hospital Tübingen, Dept. of Orthopaedic Surgery, Germany

MSc Sophie-Maria Kliesch, Quality Analysis GmbH, Germany

Marita Munz, University Hospital Tübingen, Dept. of Oral and Maxillofacial Surgery, Germany

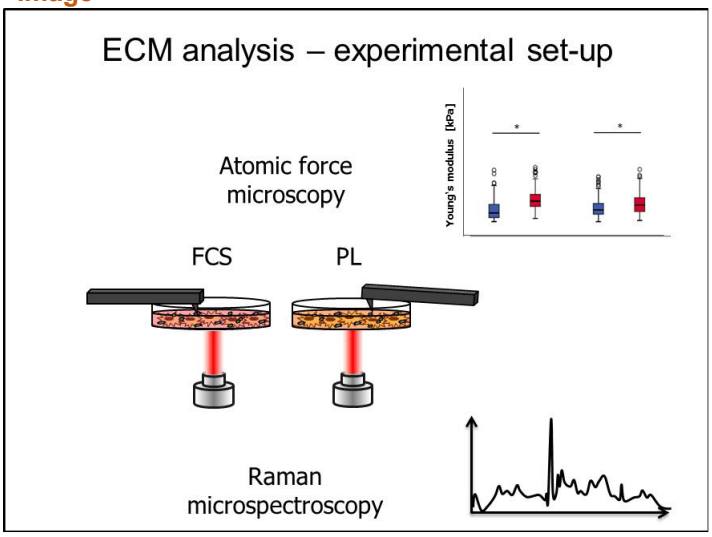
Prof Dr Dr Siegmar Reinert, University Hospital Tübingen, Dept. of Oral and Maxillofacial Surgery, Germany

Abstract

Statement of the Problem: For clinical applications of stem cell-based therapies, animal component-free culture conditions are required. In previous studies, we detected robust mineralization of jaw periosteal cells (JPCs) under cultivation with clinical approved human platelet lysate (hPL) compared to FCS conditions. In the present study, we performed qualitative analyses of the extracellular matrix (ECM) formed by JPCs under hPL and FCS culture conditions.

Methodology & Theoretical Orientation: JPCs were induced osteogenically under FCS and hPL culture conditions. At the end of osteogenic differentiation, biochemical composition of the formed precipitates was analyzed by Raman micro-spectroscopy and mechanical properties were assessed by atomic force microscopic (AFM) measurements. Findings: By Raman analyses, higher phosphate, lower carbonate content and higher crystallinity of hydroxyapatite minerals were detected under hPL culture conditions. Furthermore, regarding the quality of the collagen network, higher ratios of proline/hydroxyproline and higher collagen cross-linking were detected in hPL-cultured JPCs. Since hPL-supplementation leads to nearly equal production of the precursor protein proline and the mature protein hydroxyproline, these findings might indicate higher elastic properties of the collagen network in contrast to the FCS supplementation. However, cross-linking seems to be higher under hPL culture conditions. When areas of cell monolayers without precipitates were monitored by AFM, higher Young's modulus of untreated and osteogenically induced JPCs under FCS compared to hPL culture conditions were detected. The opposite was the case for the formed precipitates: under hPL conditions, precipitates formed by JPCs showed significantly higher Young's modulus than those formed under FCS culturing. Conclusion & Significance: In the present study, we detected significant differences in the biochemical composition and the mechanical properties of the mineralized extracellular matrix formed by hPL- and FCS-cultured JPCs. The combined technologies represent an optimal tool to assess the quality of in vitro formed bone tissue.

Image



Recent Publications (minimum 5)

1. Platelet Lysate: The Better Choice for Jaw Periosteal Cell Mineralization. Wanner Y, Umrath F, Waidmann M, Reinert S, Alexander D. Stem Cells Int. 2017;2017:8303959. doi: 10.1155/2017/8303959. Epub 2017 Dec 17.
2. Raman Spectroscopic Analyses of Jaw Periosteal Cell Mineralization. Brauchle E, Carvajal Berrio D, Rieger M, Schenke-Layland K, Reinert S, Alexander D. Stem Cells Int. 2017;2017:1651376. doi: 10.1155/2017/1651376. Epub 2017 Jan 23.
3. Surface biofunctionalization of β-TCP blocks using aptamer 74 for bone tissue engineering. Ardjomandi N, Huth J, Stamov DR, Henrich A, Klein C, Wendel HP, Reinert S, Alexander D. Mater Sci Eng C Mater Biol Appl. 2016 Oct 1;67:267-275. doi: 10.1016/j.msec.2016.05.002. Epub 2016 May 13.
4. Coating of ß-tricalcium phosphate scaffolds-a comparison between graphene oxide and poly-lactic-co-glycolic acid. Ardjomandi N, Henrich A, Huth J, Klein C, Schweizer E, Scheideler L, Rupp F, Reinert S, Alexander D. Biomed Mater. 2015 Aug 4;10(4):045018. doi: 10.1088/1748-6041/10/4/045018.
5. Phenotypic characterization of a human immortalized cranial periosteal cell line. Alexander D, Biller R, Rieger M, Ardjomandi N, Reinert S. Cell Physiol Biochem. 2015;35(6):2244-54. doi: 10.1159/000374029. Epub 2015 Apr 9.
6. Selection of osteoprogenitors from the jaw periosteum by a specific animal-free culture medium. Alexander D, Rieger M, Klein C, Ardjomandi N, Reinert S. PLoS One. 2013 Dec 9;8(12):e81674. doi: 10.1371/journal.pone.0081674. eCollection 2013.

Photograph



Biography

Dr. Alexander has her expertise in bone tissue engineering. The aim of her research focus is to develop an optimal stem cell source and appropriate biomaterials for future regeneration of maxillofacial bone defects. Therefore, her research group characterizes jaw periosteal cells and their in vitro osteogenic capacity and establishes optimal culture conditions and biofunctionalization strategies for biomaterials in view of future clinical performance. Related thereto, the establishment of suitable cell imaging approaches in order to assess cellular dynamics and biochemical changes of living cells represents a present focus of Alexander's work group.

Email:dorothea.alexander@med.uni-tuebingen.de

Notes/Comments: